

WHAT IS CLAIMED IS:

1. A laser irradiation apparatus for simultaneously irradiating a substrate with a laser beam from a front and a back surface of a substrate, wherein said apparatus comprises means for moving said substrate in a direction parallel to the direction of gravity.

2. An apparatus according to claim 1, wherein a non-single crystal semiconductor film is formed over said front surface of said substrate.

3. An apparatus according to claim 1, further comprising a chamber for arranging said substrate, wherein an internal atmosphere of said chamber is adjustable in the range between an atmospheric pressure and 10^{-3} Pa.

4. An apparatus according to claim 1, further comprising a chamber for arranging said substrate, wherein an internal atmosphere of said chamber is formed of gases such as Ar, H₂, N₂, He, or a gaseous mixture thereof.

5. An apparatus according to claim 1, further comprising heating means for heating at least the irradiation region of said first laser beam and the irradiation region of said second laser beam in said substrate between 10°C and 500°C.

6. An apparatus according to claim 1, further comprising heating means for heating at least the irradiation region of said first laser beam and the irradiation region of said second laser beam in said substrate between 200°C and 400°C.

7. An apparatus according to claim 1, wherein the energy of said first laser beam is higher than the energy of said second laser beam.

8. An apparatus according to claim 1, wherein a ratio of the energy of said first laser beam and the energy of said second laser beam is between 1 to 1 and 10 to 1.

9. An apparatus according to claim 1, wherein a non-single crystal semiconductor film is formed on a surface of said substrate, and wherein the energy of said first laser beam is higher than the energy of said second laser beam.

10. An apparatus according to claim 1, wherein a non-single crystal semiconductor film is formed on a surface of said substrate, and wherein a ratio of the energy of said first laser beam and the energy of said second laser beam is between 1 to 1 and 10 to 1.

11. An apparatus according to claim 1, wherein said first laser beam and said second laser beam are excimer lasers.

12. An apparatus according to claim 1, wherein said first laser beam and said second laser beam are XeCl excimer lasers.

13. An apparatus according to claim 1, further comprising at least a load/unload chamber, a transfer chamber, a preheat chamber, a laser irradiation chamber, and a cooling chamber.

14. A laser irradiation apparatus for simultaneously irradiating a substrate with a laser beam from a front and a back surface of a substrate,

wherein a shape of an irradiation region by a first laser beam irradiated from the front surface and a shape of an irradiation region by a second laser beam irradiated from the back surface are a linear shape or a band shape,

wherein the irradiation region by said first laser and the irradiation region by said second laser beam are parallel to each other over said substrate, and

wherein said apparatus comprises means for moving said substrate in a width direction of said irradiation region when said first laser beam and said second laser beam are being irradiated.

15. An apparatus according to claim 14, wherein a non-single crystal semiconductor film is formed over said front surface of said substrate.

16. An apparatus according to claim 14, further comprising means of arranging said substrate in a direction parallel to the direction of gravity when said first laser beam and said second laser beam are being irradiated.

17. An apparatus according to claim 14, further comprising a chamber for arranging said substrate, wherein an internal atmosphere of said chamber is adjustable in the range between an atmospheric pressure and 10^{-5} Pa.

18. An apparatus according to claim 14, further comprising a chamber for arranging said substrate, wherein an internal atmosphere of said chamber is formed of gases such as Ar, H₂, N₂, He, or a gaseous mixture thereof.

19. An apparatus according to claim 14, further comprising heating means for heating at least the irradiation region of said first laser beam and the irradiation region of said second laser beam in said substrate between 10°C and 500°C.

5 20. An apparatus according to claim 14, further comprising heating means for heating at least the irradiation region of said first laser beam and the irradiation region of said second laser beam in said substrate between 200°C and 400°C.

10 21. An apparatus according to claim 14, wherein the energy of said first laser beam is higher than the energy of said second laser beam.

22. An apparatus according to claim 14, wherein a ratio of the energy of said first laser beam and the energy of said second laser beam is between 1 to 1 and 10 to 1.

15 23. An apparatus according to claim 14, wherein a non-single crystal semiconductor film is formed on a surface of said substrate, and wherein the energy of said first laser beam is higher than the energy of said second laser beam.

20 24. An apparatus according to claim 14, wherein a non-single crystal semiconductor film is formed on a surface of said substrate, and wherein a ratio of the energy of said first laser beam and the energy of said second laser beam is between 1 to 1 and 10 to 1.

25 25. An apparatus according to claim 14, wherein said first laser beam and said second laser beam are excimer lasers.

26. An apparatus according to claim 14, wherein said first laser beam and said second laser beam are XeCl excimer lasers.

27. An apparatus according to claim 14, further comprising at least a load/unload chamber, a transfer chamber, a preheat chamber, a laser irradiation chamber, and a cooling chamber.

28. A laser irradiation apparatus for simultaneously irradiating a substrate with a laser beam from a front and a back surface of a substrate,

wherein a shape of an irradiation region of a first laser beam irradiated from the front surface and a shape of an irradiation region of a second laser beam irradiated from the back surface are a linear shape or a band shape,

wherein the irradiation region of said first laser and the irradiation region of said second laser beam are parallel to each other,

wherein a width of the irradiation region of said first laser beam is smaller than the irradiation region of said second beam irradiated from the back surface, and

wherein said apparatus comprises means for moving said substrate in the width direction of said irradiation region when said first laser beam and said second laser beam are being irradiated.

29. An apparatus according to claim 28, wherein a non-single crystal semiconductor film is formed over said front surface of said substrate.

30. An apparatus according to claim 28, further comprising means of arranging said substrate in a direction parallel to the direction of gravity when said first laser beam and said second laser beam are being irradiated.

5 31. An apparatus according to claim 28, further comprising a chamber for arranging said substrate, wherein an internal atmosphere of said chamber is adjustable in the range between an atmospheric pressure and 10^{-3} Pa.

10 32. An apparatus according to claim 28, further comprising a chamber for arranging said substrate, wherein an internal atmosphere of said chamber is formed of gases such as Ar, H₂, N₂, He, or a gaseous mixture thereof.

15 33. An apparatus according to claim 28, further comprising heating means for heating at least the irradiation region of said first laser beam and the irradiation region of said second laser beam in said substrate between 10°C and 500°C.

20 34. An apparatus according to claim 28, further comprising heating means for heating at least the irradiation region of said first laser beam and the irradiation region of said second laser beam in said substrate between 200°C and 400°C.

35. An apparatus according to claim 28, wherein the energy of said first laser beam is higher than the energy of said second laser beam.

25 36. An apparatus according to claim 28, wherein a ratio of the energy of said first laser beam and the energy of said second laser beam is between 1 to 1 and 10 to 1.

37. An apparatus according to claim 28, wherein a non-single crystal semiconductor film is formed on a surface of said substrate, and wherein the energy of said first laser beam is higher than the energy of said second laser beam.

5 38. An apparatus according to claim 28, wherein a non-single crystal semiconductor film is formed on a surface of said substrate, and wherein a ratio of the energy of said first laser beam and the energy of said second laser beam is between 1 to 1 and 10 to 1.

10 39. An apparatus according to claim 28, wherein said first laser beam and said second laser beam are excimer lasers.

15 40. An apparatus according to claim 28, wherein said first laser beam and said second laser beam are XeCl excimer lasers.

41. An apparatus according to claim 28, further comprising at least a load/unload chamber, a transfer chamber, a preheat chamber, a laser irradiation chamber, and a cooling chamber.

20 42. A method of irradiating a laser in which a laser beam is simultaneously irradiated from a front surface and a back surface of a substrate,

wherein a shape of a first laser beam irradiated from said front surface and of an irradiation region of a second laser beam irradiated from said back surface of said substrate are either a linear shape or a band shape,

wherein an irradiation region of said first laser beam and the irradiation region of said second laser beam are parallel with each other, and

wherein said substrate is moved in the direction of the width of said irradiation region while irradiating said first laser beam and said second laser beam.

43. A method according to claim 42, wherein a non-single crystal semiconductor film is formed on the front surface of said substrate, and wherein the energy of said first laser beam irradiated from the front surface is higher than the energy of said second laser beam irradiated from the back surface.

44. A method according to claim 42, wherein a non-single crystal semiconductor film is formed on a surface of said substrate, and wherein a ratio of the energy of said first laser beam irradiated from the front surface and the energy of said second laser beam irradiated from the back surface is between 1 to 1 and 10 to 1.

45. A method according to claim 42, wherein said substrate is arranged in a direction parallel to the direction of gravity when said first laser beam and said second laser beam are being irradiated.

46. A method according to claim 42, wherein said substrate is disposed into an atmosphere that has a pressure of between an atmospheric pressure and 10^{-3} Pa.

47. A method according to claim 42, wherein said substrate is disposed into an atmosphere formed of gases such as Ar, H₂, N₂, He, or a gaseous mixture.

48. A method according to claim 42, wherein at least the irradiation region of said first laser beam and the irradiation region of said second laser beam in said substrate is heated between 10°C and 500°C.

49. A method according to claim 42, wherein said first laser beam and said second laser beam are excimer lasers.

50. A method according to claim 42, wherein said first laser beam and said second laser beam are XeCl excimer lasers.

51. A method of irradiating a laser in which a laser beam is simultaneously irradiated from a front surface and a back surface of a substrate,

wherein a shape of said first laser beam irradiated from the front surface of said substrate and of an irradiation region of said second laser beam irradiated from the back surface of said substrate are either a linear shape or a band shape,

wherein an irradiation region of said first laser beam and the irradiation region of said second laser beam are parallel with each other,

wherein a width of the irradiation region of said first laser beam is smaller than a width of the irradiation region of said second laser beam irradiated from said back surface, and

wherein said substrate is moved in a direction of the width of said irradiation region while irradiating said first laser beam and said second laser beam.

52. A method according to claim 51, wherein a non-single crystal semiconductor film is formed on the front surface of said substrate, and wherein the energy of said

first laser beam irradiated from the front surface is higher than the energy of said second laser beam irradiated from the back surface.

53. A method according to claim 51, wherein a non-single crystal semiconductor film is formed on a surface of said substrate, and wherein a ratio of the energy of said first laser beam irradiated from the front surface and the energy of said second laser beam irradiated from the back surface is between 1 to 1 and 10 to 1.

54. A method according to claim 51, wherein said substrate is arranged in a direction parallel to the direction of gravity when said first laser beam and said second laser beam are being irradiated.

55. A method according to claim 51, wherein said substrate is disposed into an atmosphere that has a pressure of between an atmospheric pressure and 10^{-3} Pa.

56. A method according to claim 51, wherein said substrate is disposed into an atmosphere formed of gases such as Ar, H₂, N₂, He, or a gaseous mixture.

57. A method according to claim 51, wherein at least the irradiation region of said first laser beam and the irradiation region of said second laser beam in said substrate is heated between 10°C and 500°C.

58. A method according to claim 51, wherein said first laser beam and said second laser beam are excimer lasers.

59. A method according to claim 51, wherein said first laser beam and said second laser beam are XeCl excimer lasers.

60. A semiconductor device, wherein a crystalline semiconductor film having a crystal grain size of between 500 nm and 3 μ m is utilized as an active layer.

61. A method of manufacturing a semiconductor device having a TFT formed on a substrate, comprising the steps of:

forming a non-single crystal semiconductor film on said substrate, and simultaneously irradiating a first laser beam irradiated from a front surface of said substrate and a second laser beam irradiated from a back surface of said substrate to thereby form a crystalline semiconductor film.

62. A method according to claim 61, wherein the energy of said first laser beam is higher than the energy of said second laser beam.

63. A method of manufacturing a semiconductor device having a TFT formed on a substrate, comprising the steps of:

forming a non-single crystal semiconductor film on said substrate;
introducing a metal element for promoting the crystallization of a semiconductor into said non-single crystal semiconductor film; and simultaneously irradiating a first laser beam irradiated from a front surface of said substrate and a second laser beam irradiated from a back surface of said substrate to thereby form a crystalline semiconductor film.

64. A method according to claim 63, wherein the energy of said first laser beam is higher than the energy of said second laser beam.

65. A method of manufacturing a semiconductor device having a TFT formed on a substrate, comprising the steps of:

forming a non-single crystal semiconductor film on said substrate;

introducing a metal element for promoting the crystallization of a semiconductor into said non-single crystal semiconductor film;

performing heat treatment to said non-single crystal semiconductor film to thereby form a crystalline semiconductor film; and

simultaneously irradiating a first laser beam irradiated from a front surface of said substrate and a second laser beam irradiated from a back surface of said substrate to said crystalline semiconductor film.

66. A method according to claim 65, wherein the energy of said first laser beam is higher than the energy of said second laser beam.

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